Space Weather Technical Forecast

Issued on Wednesday, 28 June 2023 at 01:11 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Low to Moderate solar activity expected. Active fluence likely.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Moderate, with an M1.2 flare peaking at 27/1514 UTC, originating from AR3340 in the northwest quadrant. There are eight sunspot regions on the visible disc, with AR3354 in the northeastern quadrant the most significant of these. It has developed rapidly in the last 24 hours, and continues to show signs of potentially developing a delta spot. The remaining regions all appear relatively small and simple. A dimming from near centre disc around 27/0200UTC looked as though it may have produced a CME, but nothing has been seen in coronagraph imagery. A further filament eruption near AR3354 is still being assessed.

Solar Wind / Geomagnetic Activity: The solar wind, as observed at L1, has followed a declining trend as the influence from a CME which arrived late on 24 June continues to wane. Wind speed initially varied between 500-570 km/s, and is now around 440-500 km/s. Density has been mostly below average. Total magnetic field strength was weak, at 6 nT or below, with the north-south component also varying weakly. Phi angle was mainly negative (towards the Sun). Geomagnetic activity was Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV), as observed by GOES16, was at background levels. High energy electron flux (greater than 2MeV), as observed by GOES16, reached high levels at the diurnal maximum with a peak value of 2110pfu at 27/1625 UTC. The associated 24-hour fluence rose during the day but was still below Active, with an observed value of 6.23e7 integrated pfu at 28/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low to Moderate, with a slight chance of X-class flares, mainly from AR3354.

Solar Wind / Geomagnetic Activity: A CME which was thought to potentially give Earth a glancing blow during 27 June is now considered more likely to have missed. Solar wind speeds are gradually declining following the arrival of a CME on 24 June. Coronal hole 18 is a recurrent feature, which appears to have had limited effects on Earth on the last rotation, and is smaller and more fragmented on this rotation with only a weak connection expected. It is perhaps more likely that any coronal hole influence may simply prolong the tail of the CME effects with slightly elevated wind speeds.
Geomagnetic activity is forecast to be mainly Quiet to Unsettled, perhaps reaching Active should any CME or HSS influence occur.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is most likely to remain at background levels but with a slight chance of reaching the S1/Minor

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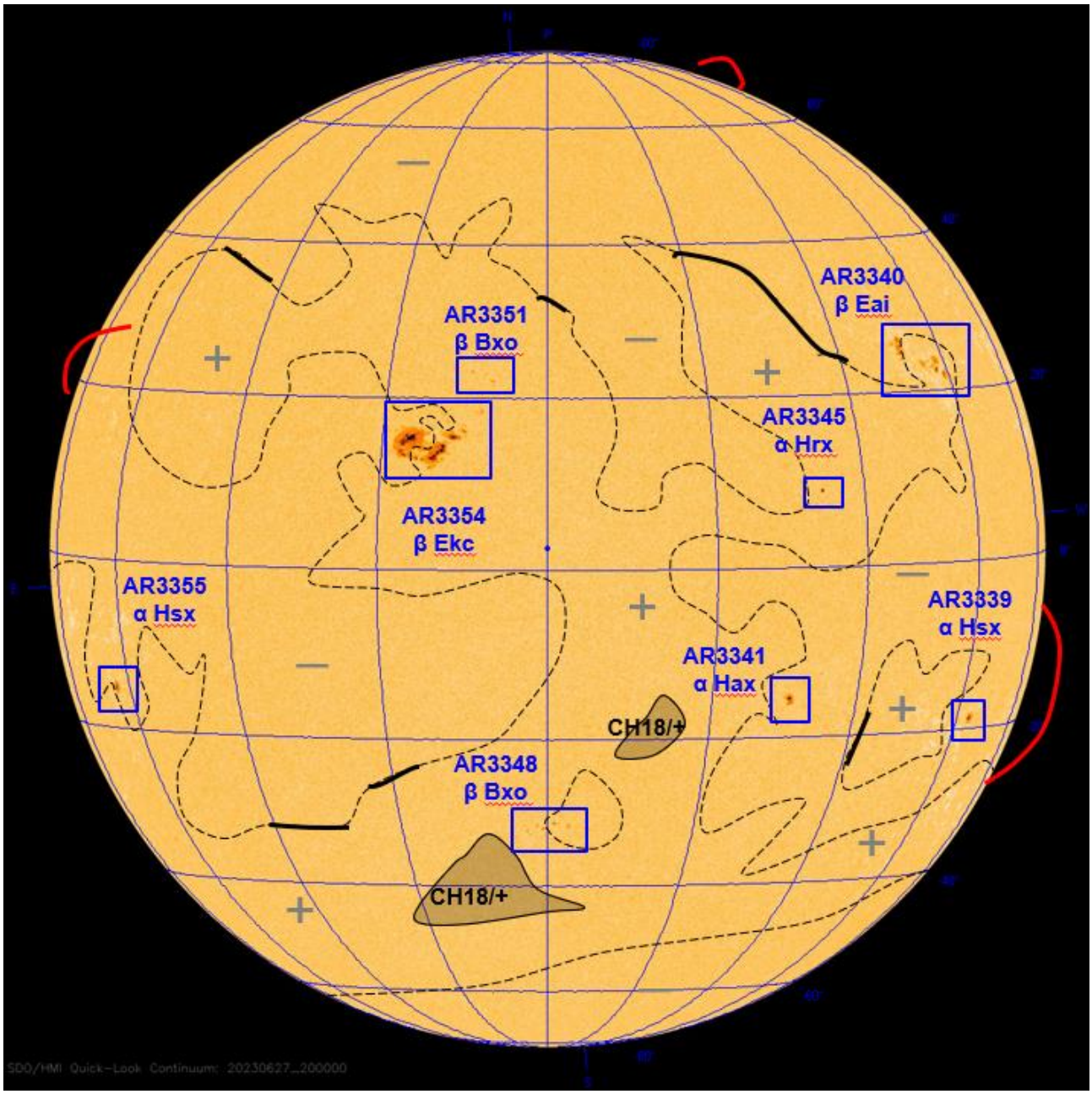
Storm level, mainly due to AR3354 and AR3340. High energy electron flux (greater than 2MeV) is likely to continue to peak at high levels at the diurnal maxima in the coming days. Above Active (1e8 integrated pfu) fluence is likely through this period.

Figure 1. Solar Analysis Valid 27/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME which left the Sun on 22 June was thought to potentially give Earth a glancing blow during 27 June, but this is now considered more likely to have missed.

Solar wind speeds are gradually declining following the arrival of a CME on 24 June. Coronal hole 18 is a recurrent feature, which appears to have had limited effects on Earth on the last rotation, and is smaller and more fragmented on this rotation. In addition, on the previous rotation there was a further coronal hole nearer the equator which isn't present this time around. As such, although persistence indicates possible speeds of 500km/s, this magnitude is likely to be reduced due to the changes from the previous rotation, with only a weak connection expected. It is perhaps more likely that any coronal hole influence may simply prolong the tail of the CME effects with slightly elevated wind speeds.

Geomagnetic activity is forecast to be mainly Quiet to Unsettled, perhaps reaching Active should any CME or HSS influence occur.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

No Earth directed CMEs are currently expected.

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Figure 2: MOSWOC Enlil showing a general decline in wind speeds through the next few days, but perhaps with a prolonged period of slightly elevated wind speeds due to HSS influence from CH18.

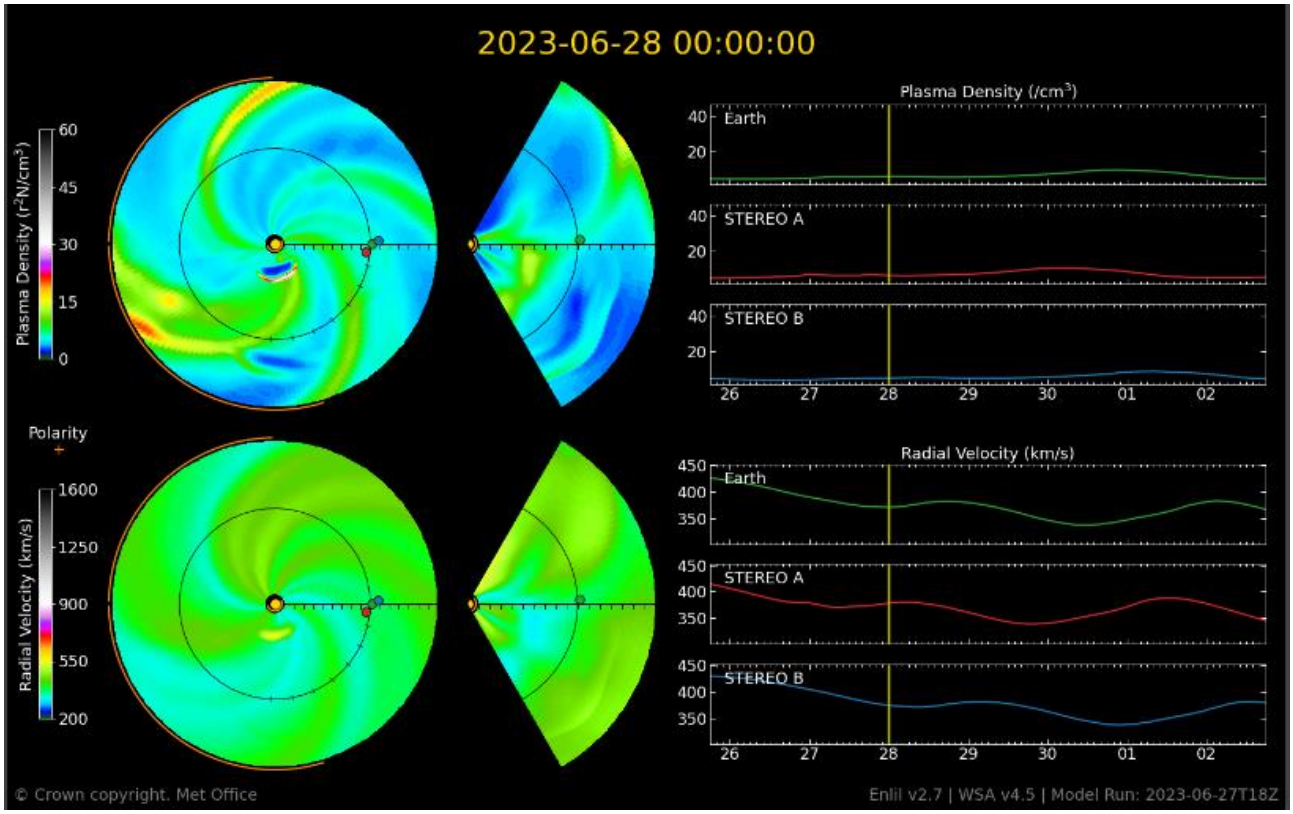
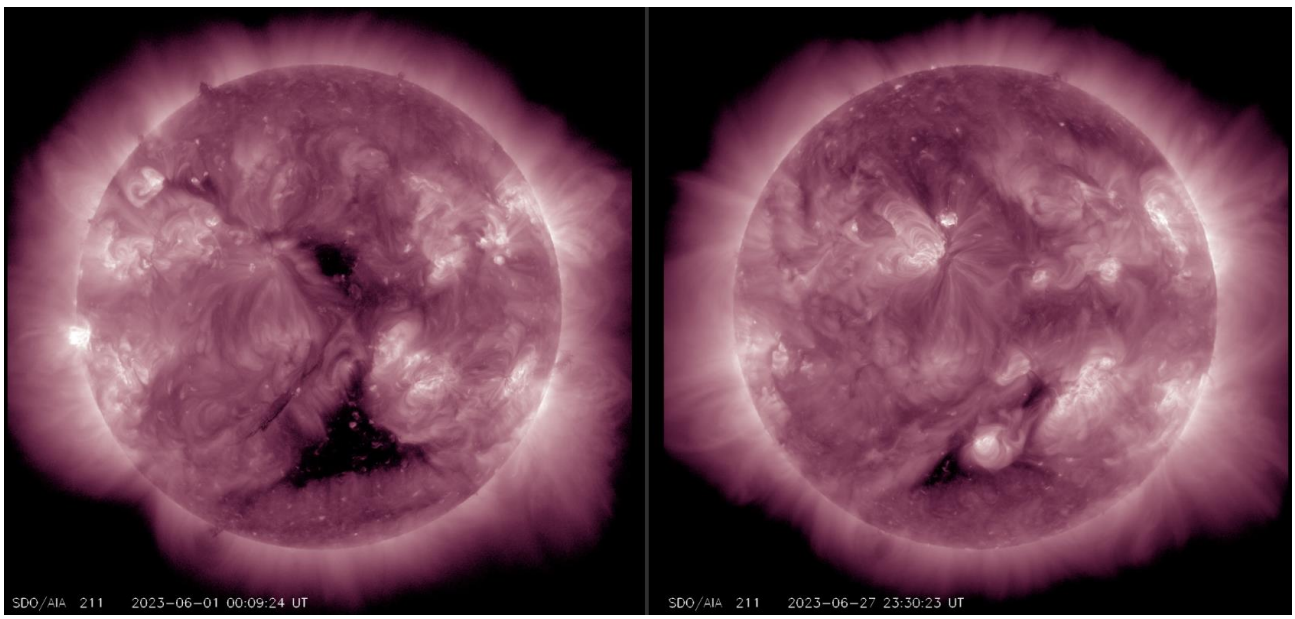


Figure 3: Coronal hole comparison with previous rotation (left) and current rotation (right). This shows significant changes from the previous rotation.



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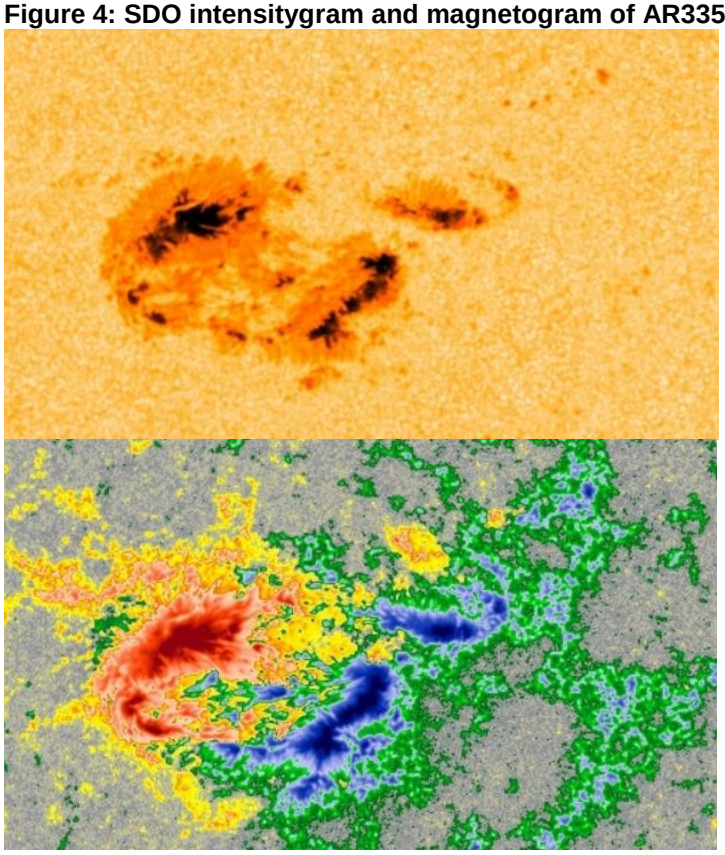
Radio Blackouts - X-Ray Flares:
There are eight sunspot regions on visible disc. AR3354 is the most significant region on the disc in the northeast quadrant. This has grown rapidly in the last 24 hours, and is showing signs of developing a delta spot. AR3340 in the northwest also remains of interest following M-class activity, but does not appear to be significantly complex. The remaining regions all appear relatively small and simple at this time. Helioseismology suggests that a number of regions will rotate onto the visible disc through the next four days, although limited activity has been observed emanating from the far side of the Sun.

Solar activity is forecast to be Low to Moderate, with a slight chance of Strong flare activity.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	50	50	50
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 4: SDO intensitygram and magnetogram of AR3354, which has grown significantly recently.



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, as observed by GOES16, is at background levels and is most likely to remain so throughout the period. However there is a slight chance of reaching the S1/Minor Storm threshold, mainly due to AR3354 and AR3340. AR3354 in particular has developed rapidly and is the reason for the increase in the probability of radiation storms.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) has reached high levels at the diurnal maximum on 27 June, likely due to the influence of recent CME effects. The British Antarctic Survey Radiation Belt Model (BAS-RBM) also suggests that charging may have occurred below GEO. As the CME influence wanes and the radiation belt relaxes, electron flux levels may continue to increase a little further. Further significant geomagnetic activity is unlikely in the coming days, which means that this will probably not be a significant factor in reducing the flux levels.

Electron fluence values are currently rising, and may reach above Active (1e8 integrated pfu) in the next day or so. Thereafter, a slow decline is most likely. REFM is forecasting levels near Active by the 29 June, then a slight decrease, which seems reasonable although with low confidence in the exact magnitude of peak fluence levels.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	60	60	50	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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Figure 5: MOSWOC REFM showing fluence near Active.

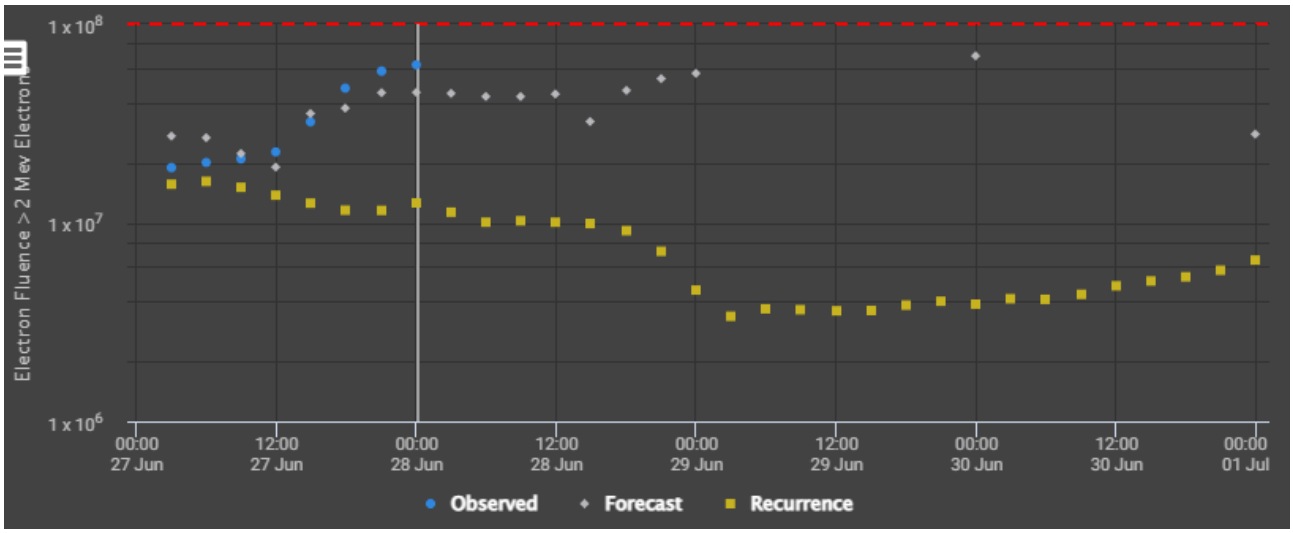
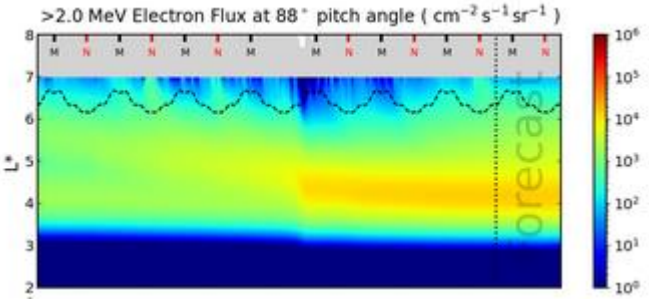


Figure 6: The BAS-RBM modelling an increase in electron flux below GEO.



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